Capability Assessment of South African NEA Observations + Recent NEA Observations on SAAO 1-meter

Henry Throop
University of Pretoria /
Planetary Science Institute
(NASA Representative)

There is a huge gap in global observational coverage of asteroids…
and it is centered on South Africa, which has a lot of telescopes!

How South Africa can play a role in the Asteroid Grand Challenge and NEA studies

X	Discovering new NEAs	Requires wide-angle robotic telescopes
	Immediate followup post-discovery; orbital measurements	Geographic advantage of SA fills major hole
	Characterization: Shape, spin rate, composition	Ready access to moderate telescopes (~1 m); amateurs

Inventory of telescopes in SA

Name	Aperture	Access	Comments
SAAO 1m	1 m	Block scheduled	PI at telescope
SAAO 1.9m	1.9 m	Block scheduled	PI at telescope
SALT	10 m	Queue	Allows for ToO
LCOGT	11 x 1m	Queue + ToO, robotic	SA (3) / Chile (3) / Australia (2) SA has 300 hours/semester across entire network
New SAAO 1m remote	1 m	Remote; Queue?	30-45' FOV (wider than anything else in SA?). First light 2015? Sited in dome of SAAO
Boyden	1.5 m		1933 Bloemfontein. Refurbished 1999.
Amateur telescopes	0.3 - 0.4 m		Many

SAAO 1-meter, 1.9-meter

- 1-meter 1963; 1.9-meter 1933
- Narrow FOVs (5', 2.5')
- Similar instrumentation
  - SHOC = high-speed imager
  - STE3/STE4 = CCD imagers
  - Focal reducer and prime-focus imager both under development; will allow wider FOV (up to 23' on 1.9-m).
- Telescope operation is very manual. Requires PI at telescope.
- Narrow FOV → good for measuring light curves for slow-moving bodies on well-known orbits, but not for discovery or uncertain orbits
- No non-sidereal tracking → harder to track fast-moving targets.
- Somewhat primitive interface (e.g., no target position lookups)

SALT

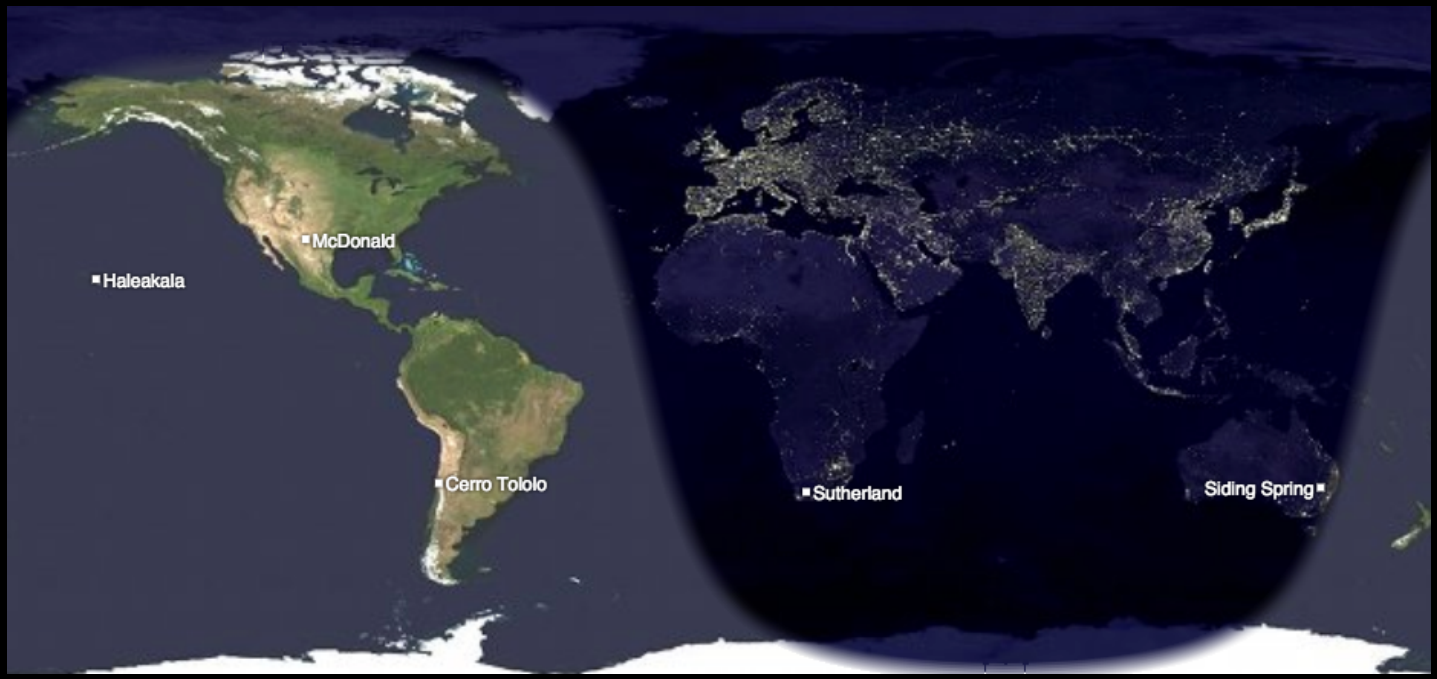
- Deep imaging for faint targets
- Time is highly competitive
- Fixed-elevation pointing, so not practical to do observations > 1-2 hours.
- NEA studies for Grand Challenge does not require large aperture of SALT.
- Ideal for faint, rapid rotators: Kwiatkowski et al
  - Used for H > 21.5 asteroids by Polish group
  - Diameters 20-100 meters, periods 1-40 min.

LCOGT

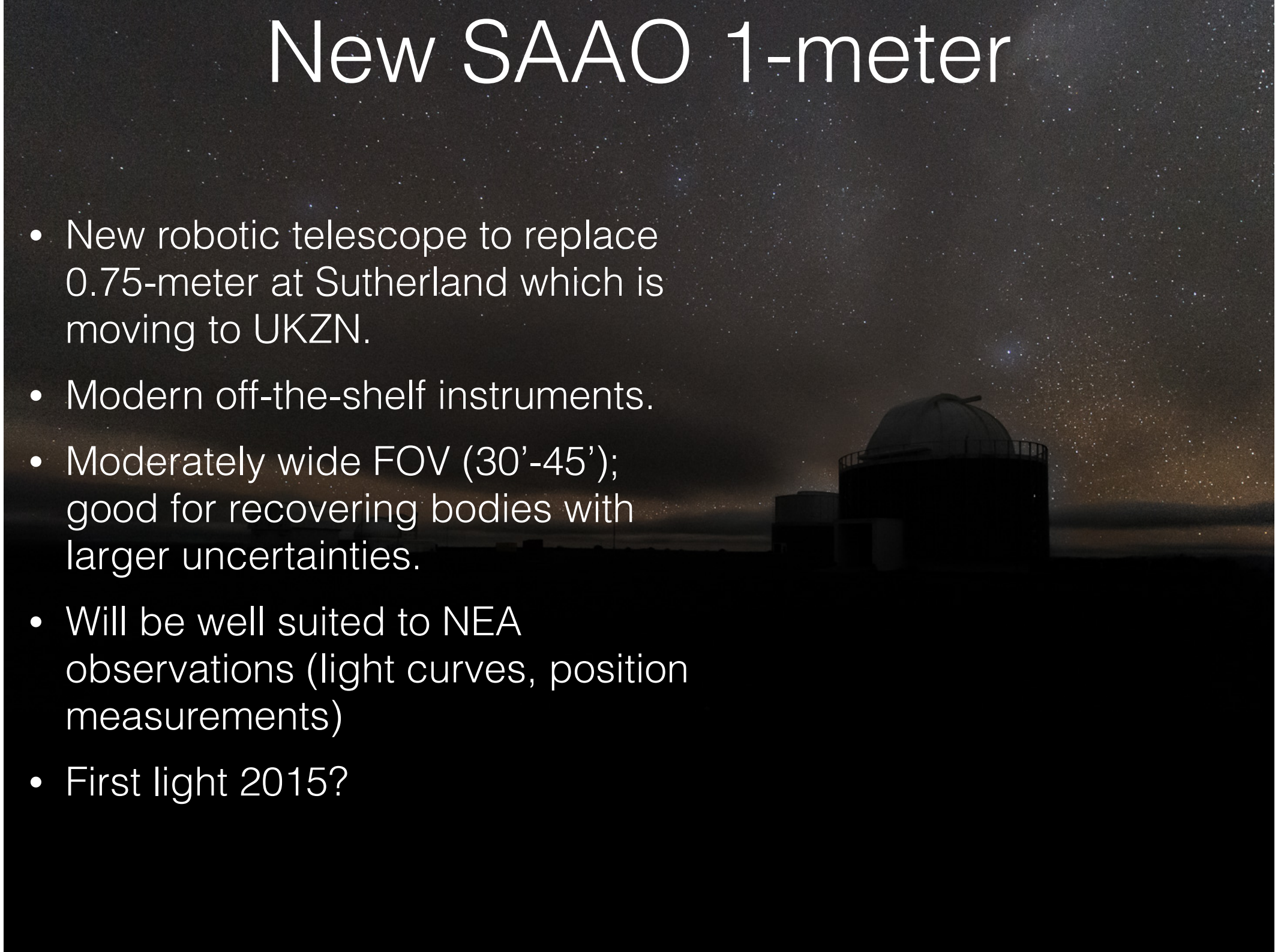
Las Cumbres Observatory Global Telescope Network

- 9 x 1-meter telescopes
  - Sutherland (3), CTIO (3), Siding Spring (2), McDonald (1)
- 2 x 2-meter telescopes
  - Hawaii, Siding Spring

- LCOGT is private, but SA has ~300 hours/semester on 1-meter network. No time on 2-meter.
- Fully robotic, ToO, queue, new instruments, good pipeline, etc.
- Small-bodies proposals accepted by Gulbis (2014/1, KBOs), Throop (2014/2, Comet).



New SAAO 1-meter



- New robotic telescope to replace 0.75-meter at Sutherland which is moving to UKZN.
- Modern off-the-shelf instruments.
- Moderately wide FOV (30'-45'); good for recovering bodies with larger uncertainties.
- Will be well suited to NEA observations (light curves, position measurements)
- First light 2015?

Amateur Observers

- South Africa has a very strong amateur community. Dark skies, good observers.
- I gave NEA talk to ~100 amateurs at annual 'ScopeX' conference in September.
- ~6 observers from Gauteng / FS / NW / Limpopo have serious interest in starting a NEO program through ASSA.
- Telescopes in 10-16" range with CCDs. Few nights/month.
- No observations yet but stay tuned.
- Working with Vishnu Reddy (PSI).

Astronomical Society of Southern Africa
ASSA

ASSA *NEO-Watch*

Call for Observers

ASTEROID GRAND CHALLENGE

INTRODUCTION

NASA has embarked on the Asteroid Grand Challenge, a program to "find all asteroid threats to human populations and know what to do about them.". The Asteroid Grand Challenge involves detecting all near earth objects (NEOs) larger than 100 metres, characterise them and determine a way to mitigate them. But while dedicated search programs do a great job of finding these objects, follow up observations are required to characterise them and more precisely define their orbits. This pastime is well suited to dedicated amateur astronomers.

THE GAP IN OBSERVATIONAL COVERAGE

There are hundreds of NEOs that need observation. While there is excellent coverage in the northern hemisphere, coverage from the southern hemisphere is less, and from South Africa is non-existent! Therefore a gap exists in these time dependent observations, where South Africa enjoys a unique position on the globe, and ASSA amateurs are well positioned to make a significant contribution to this program.

WHAT OBSERVATIONS ARE REQUIRED ?

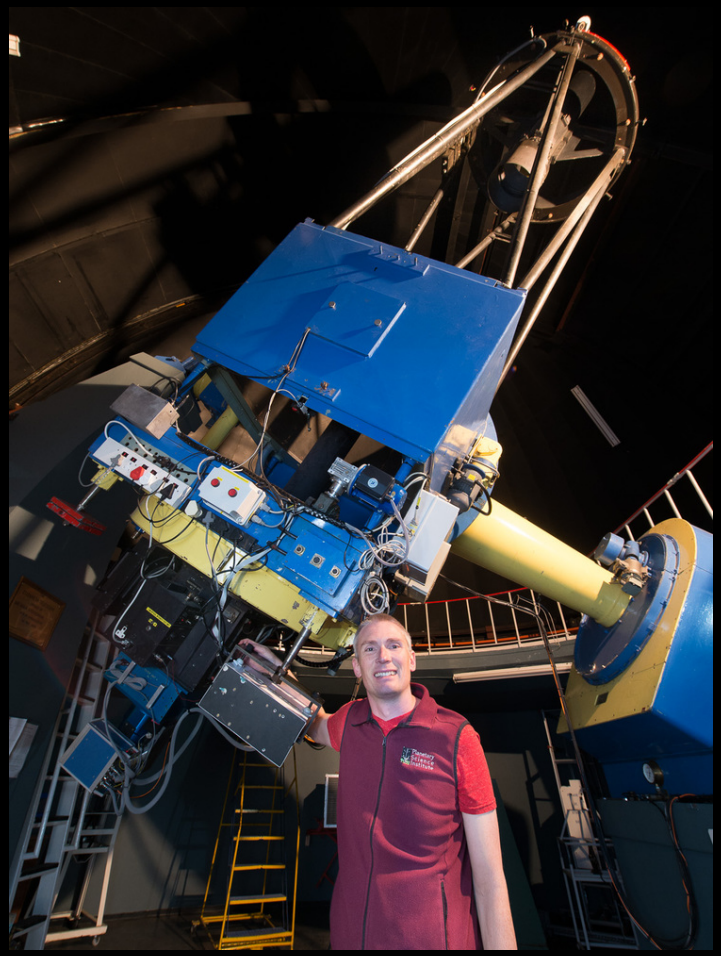
Most of the NEOs detected by search programs are never observed again! Follow up observations are required in the following disciplines:

- **Astrometry** - precise positional measurements as early as possible after detection, in order to refine the orbit of the object and prevent it being lost.
- **Photometry** - determining rotational light-curves (typically 4-12 hour periods) when near periapse. From this can be derived some idea of the size and shape, spin rate, pole orientation, and duplicity or the presence of satellite objects.
- **Spectroscopy** - measurement of reflection spectra to assist in determining composition, type and family membership, generally referred to as taxonomy.

If you believe you can make a contribution to this program, please go to page 2.....

NEA Monitoring from SAAO 1-meter

- Throop *et al* given two weeks on 1-meter w/ STE4.
- Goal was to make some initial observations to assess capability of telescope.
  - Do photometry on handful of NEAs
  - Measure positions for NEAs, comets



- Results:
  - Observed for 1 full night out of 7, June 2014
  - 7 nights upcoming in December 2014

Capability of 1-meter

- Observations are very manual. Robotic telescope would allow for larger ongoing programs.
- Some non-sidereal support would be helpful. *e.g.*:
  - Actual RA/Dec populated into FITS header
  - Target lookups from JPL Horizons
  - Non-sidereal tracking not necessary
- German equatorial mount can't point all the way to the west
  - Max ~6 hours on single target
- Instrumentation is not optimized (e.g., 30 sec to readout 30-sec CCD exposure)

Asteroid 3288 Selucus

NEA, perihelion 1.1 AU, e = 0.45, H=15.3, v = 17, discovered 1982

June 2014, SAAO 1-meter
Throop / Reddy / Morris

~ 5 hours of light-curve data

Period = 72 hours